19990719 025

The Fox Project: Advanced Development of Systems Software

R&D Status Report
April 1 to June 30, 1999

School of Computer Science
Carnegie Mellon University
Pittsburgh, PA 15213

The long-term objectives of the Carnegie Mellon Fox Project are to improve the design and construction of systems software and to further the development of advanced programming language technology. We use principles and techniques from the mathematical foundations of programming languages, including semantics, type theory, and logic, to design and implement systems software, including operating systems, network protocols, and distributed systems. Much of the implementation work is conducted in the Standard ML (SML) language, a modern functional programming language that provides polymorphism, first-class functions, exception handling, garbage collection, a parameterized module system, static typing, and a formal semantics. This Project involves several faculty members and spans a wide range of research areas, from (1) advanced compiler development to (2) language design to (3) software system safety infrastructure.

1   Research Progress

We report on the research accomplishments during the second calendar quarter of 1999, and the research objectives for the third quarter of 1999.

Accomplishments (April-June):

- Completed the System F to TAL compiler.

- Finished VCGEN and operational semantics for resource-bounds PCC based on Java bytecode.

- Implemented LF typechecker and bytecode intermediate language for use with VCGEN.

- The TILT compiler's compilation time has been reduced by a factor of 2. The code size is within 20% of the corresponding code generated by the SML/NJ compiler.

- A parallel compilation manager for TILT has been implemented. Using this system, TILT can compile itself in under 15 minutes using 5 processors.

- Completed the proof of decidability of type equivalence for a language with singleton kinds (which validates the correctness of an algorithm used internally by the TILT compiler).

- Continued work on the Typed Assembly Language infrastructure: designing and proving correct a dialect of TAL capable of supporting type-passing optimizations. This will make it possible to compile ML to TAL using high-performance optimization strategies.

- Devised proposals for the ML2000 module and core languages.

- Completed bootstrap of the TILT compiler.

- Experimented with some interesting ideas for structuring the TILT compiler. (The "Wizard" interface, using a special representation behind the scenes, with explicit conversions into and out of the special representation for pattern matching purposes.)

Objectives (July-September):

- Test cost VCGEN on several small networking applications.

- Present thesis proposal for Java PCC with general security properties.

- Extend the TILT compilation manager to support libraries.

- Release TILT to other researchers at CMU and prepare "alpha" release of TILT.

- More versions of parallel collectors will be implemented. For example, generations and concurrency will be added.

- Extensions of the theory and implementation to contain subtyping and power kinds (useful for object-oriented extensions to the compiler) and to contain singleton types (useful particularly for compiler optimizations such as cross-module inlining).

- Design and implement a Typed Assembly Language dialect for specifying and enforcing bounds on resource consumption.

- Experiment with strategies for further improving compilation time in the TILT compiler.

- Complete write-up of metatheory of the TILT typed intermediate languages.

- Continue experimentation with the Wizard interface.

2　Noteworthy Publications

- *Flexible Type Analysis* by Karl Crary and Stephanie Weirich. Accepted for publication in the International Conference on Functional Programming, 1999.

- *Type Structure for Low-Level Programming Languages* by Karl Crary and Greg Morrisett. Accepted for publication in the International Conference on Automata, Languages and Programming, 1999.

- *What is a Recursive Module?* by Karl Crary, Robert Harper and Sidd Puri. Accepted for publication in PLDI '99. Also published as technical report CMU-CS-FOX-98-03.

3　Capital Equipment Purchases

- 1 Sharp 6/300 6.4GB 64MB 56K CT Notebook, $2,307.00

- 1 Inspiron 3500 A300GT PentiumII, $2,919.00

- 1 Inspiron 3500 A300GT PentiumII, $2,919.00

4　Key Personnel Changes

- None.

5　Noteworthy Meetings

- Federated Computing Research Conferences (FCRC) (Atlanta, GA, May 1-4, 1999)

- 1999 Conference on Programming Language Design and Implementation (Atlanta, GA, May 1-4, 1999).

6   Administrative Data

Base Funding (excludes options):
Year 1: 922,250
Year 2:
Year 3:
Year 4: 789,967
Year 5: 821,136
Year 6: 849,928
Year 7:
Total Base Funding: 3,383,381

Funded Options:
Option 1:   964,201
Option 2: 1,008,341
Option 3:
Option 4:
Option 5:   275,005

Unfunded Options:
Option 1:
Option 2:
Option 3: 423,046
Option 4: 444,260
Option 5: 648,704

Total Funding Provided to Date (both base and options): 4,175,957
Total Funding Expended to Date (both base and options): 3,627,660
Total Funding Unexpended: 548,297

Date Current Funding will be Expended: 31 DEC 1999

Funding Expended in Most Recent Quarter: 237,356

Incremental Funding required for FY 2000: 850,000

Date of Financial Data: 30 JUN 1999